PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-136158
(43)Date of publication of application : 10.05.2002

(51)Int.Cl. H02N 2/00
F02D 41/22
F02D 45/00
H01L 41/083

(21)Application number : 2000-326849
(22)Date of filing : 26.10.2000

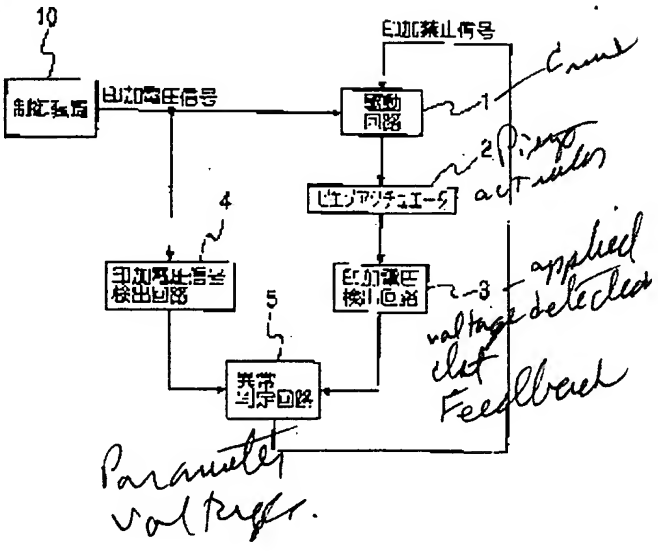
(71)Applicant : NIPPON SOKEN INC
DENSO CORP
(72)Inventor : FUKAGAWA YASUHIRO
MORITSUGU MICHIYASU
OSHIMA KENJI
KUMANO MIKIO

(54) ANOMALY DETECTOR FOR PIEZOELECTRIC ACTUATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an anomaly detector for piezoelectric actuator that is capable of detecting anomalies in a piezoelectric actuator without fail and enables enhancement of the safety thereof.

SOLUTION: The anomaly detector for actuator is provided with a drive circuit 1 that applies high voltages to a piezoelectric actuator 2 formed, by laminating a plurality of piezoelectric bodies that expand and contract according to applied voltages and accumulates electric charges there, or discharges the accumulated electric charges, an applied voltage detection circuit 3 that detects voltages actually applied to the piezoelectric actuator 2, a control device 10 that outputs to the driving circuit 1 applied voltage signals to cause the piezoelectric actuator 2 to start the application of high voltages or discharging, and an applied voltage signal detection circuit 4 that detects the applied voltage signals outputted from the control device 10. The actual applied voltages, detected through an anomaly judgment circuit 5 and the applied voltage signals, are compared with each other. Under normal conditions,



* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the malfunction detection equipment which detects the abnormalities of a piezo actuator.
[0002]
[Description of the Prior Art] Since the piezo actuator which generates the variation rate according to applied voltage by telescopic motion of a piezo electric crystal is excellent in a high response at a controllability, it is widely used for the driving gear for cars from before. Moreover, application to the fuel injection valve of an internal combustion engine, especially a common rail type injection system is also considered. On the other hand, in order for the drive of a piezo actuator to take the high voltage, when a piezo actuator will be in conditions, such as a short circuit or disconnection, energization or overvoltage is impressed for an excessive current at a piezo actuator, and there is a possibility of leading to the own breakage of a piezo actuator, as a result breakage of a system. Since it corresponds to new car regulation especially in recent years, the troubleshooting technique of a car loading device needs to be established, and also in the piezo actuator which the high voltage generates, the safety practice has been a technical problem.
[0003]
[Problem(s) to be Solved by the Invention] This invention was made in view of the above-mentioned actual condition, and the purpose is in offering the malfunction detection equipment of the possible piezo actuator of detecting the abnormalities of a piezo actuator certainly and raising the safety.
[0004]
[Means for Solving the Problem] Invention of claim 1 is malfunction detection equipment of the piezo actuator which comes to carry out two or more laminatings of the piezo electric crystal expanded and contracted according to applied voltage. The driving means which the high voltage is impressed [driving means] to this piezo actuator, and stores up a charge, or makes the accumulated charge discharge, An applied-voltage detection means to detect the electrical potential difference actually impressed to the above-mentioned piezo actuator, An applied-voltage signal output means to output the applied-voltage signal which makes the above-mentioned piezo actuator start initiation and discharge for impression of the above-mentioned high voltage to the above-mentioned driving means, It has an abnormality judging means to compare an applied-voltage signal detection means to detect the above-mentioned applied-voltage signal outputted from the above-mentioned applied-voltage signal output means with the actual applied voltage detected with the above-mentioned applied-voltage detection means and the applied-voltage signal detected with the above-mentioned applied-voltage signal detection means, and to judge abnormalities.
[0005] If the voltage waveform of this invention impressed to the above-mentioned piezo actuator at the time of charge and discharge is almost the same as that of the wave of the applied-voltage signal for impressing an electrical potential difference to a piezo actuator and abnormalities, such as a short circuit or disconnection, occur, the point that this voltage waveform impressed in fact collapses is noted. That

is, if the actual applied voltage detected with the above-mentioned applied-voltage detection means is compared with the applied-voltage signal detected with the above-mentioned applied-voltage signal detection means and the difference or ratio has separated greatly compared with always [forward], it will judge with it being unusual. Since an abnormality judging is performed based on actual applied voltage in this invention, safety can be greatly raised by more positive troubleshooting being possible and suspending charge-and-discharge actuation promptly at the time of malfunction detection.
[0006] invention of claim 2 -- the above-mentioned abnormality judging means -- the above -- actual applied voltage and the above-mentioned applied-voltage signal are integrated, respectively, in a predetermined abnormality judging period, when the difference or ratio of these addition value is in predetermined tolerance, it judges with it being normal, and when there is nothing into predetermined tolerance, it judges with abnormalities. According to an applied-voltage signal, a series of charge and discharge actuation are performed, and, specifically, actual applied voltage and the above-mentioned applied-voltage signal are integrated in the meantime, respectively. From discharge starting, in the fixed period back, if these addition value is compared as a predetermined abnormality judging period, the judgment of normal or abnormalities will be made easily.
[0007] In invention of claim 3, the above-mentioned abnormality judging period is established at the period when it is not inputted into the above-mentioned applied-voltage signal. in order to perform an abnormality judging to accuracy more, the above-mentioned applied-voltage signal inputs -- not having -- the above -- it is more desirable to perform an abnormality judging at the period when actual applied voltage and the addition value of the above-mentioned applied-voltage signal are not changed.
[0008]
[Embodiment of the Invention] Hereafter, the gestalt of 1 operation of this invention is explained based on a drawing. Drawing 1 is drawing showing the whole malfunction detection equipment configuration of the laminating mold piezo actuator 2. The driving means slack drive circuit 1 which the high voltage is impressed [circuit] to the piezo actuator 2, and stores up a charge, or makes the accumulated charge discharge, The applied-voltage detection means slack applied-voltage detector 3 which detects the electrical potential difference actually impressed to the piezo actuator 2, The control unit 10 which constitutes an applied-voltage signal output means to output the applied-voltage signal which makes the piezo actuator 2 start initiation and discharge for impression of the high voltage to the drive circuit 1, The applied-voltage signal detection means slack applied-voltage signal detector 4 which detects the applied-voltage signal outputted from a control unit 10, It has the abnormality judging circuit 5 in abnormality judging means slack which compares the actual applied voltage detected in the applied-voltage detector 3 with the applied-voltage signal detected in the applied-voltage signal detector 4, and judges abnormalities.
[0009] The piezo actuator 2 is the thing of a well-known configuration of having carried out the laminating of many piezo electric crystals fabricated a rectangle or in the shape of [circular] sheet metal, and having unified, and each piezo electric crystal consists of piezoelectric material, such as PZT. It connects with juxtaposition electrically, elongates by pouring in a charge, it contracts by removing a charge, and each piezo electric crystal by which the laminating was carried out generates a variation rate. Through a connector (****), the drive circuit 1 is connected electrically, and according to the applied-voltage signal (for example, 0-5V square wave signal) from a control unit 10, the drive circuit 1 the switching element for charge (henceforth Charge SW), or the switching element for discharge (henceforth Discharge SW), and controls the charge and discharge of the piezo actuator 2 to it. [the piezo actuator 2] In addition, this applied-voltage signal specifies the discharge-starting stage of the piezo actuator 2 for the charge initiation stage of the piezo actuator 2 based on falling of a pulse signal based on the standup of a pulse signal as below-mentioned.
[0010] Two or more switching method which switches gradually for example, at the time of charge and discharge, and performs charge and discharge at it is used for switching. By the multiplex switching method, at the time of charge, if an applied-voltage signal is inputted, charge will be started (if the rising edge of an applied-voltage signal is detected). At this time, the drive circuit 1 charges the high voltage which turned on Charge SW and carried out the pressure up in the high-voltage generating circuit which

V2) of piezo actuator applied voltage greatly from the addition value (level S2) of an applied-voltage signal, and it will exceed the above-mentioned tolerance. At this time, the abnormality judging circuit 5 judges with a piezo actuator being unusual, and outputs the impression inhibiting signal which forbids the drive of the piezo actuator 2 to the drive circuit 1.

[0016] Thus, it becomes detectable [abnormalities] by comparing the addition value A of an applied-voltage signal with the addition value B of piezo actuator applied voltage. The flow chart of this piezo actuator drive and malfunction detection is shown in drawing 3 . In addition, by above-mentioned two or more switching method, the flow chart of drawing 3 performs the charge and discharge of the piezo actuator 2, and explains it. In drawing 3 , if control starts, as for the drive circuit 1, an applied-voltage signal (for example, 0-5V) will judge high level (H) and a low level (L) at step 1 first. If an applied-voltage signal is set to H=5V from L=0V for an actuator drive, the drive circuit 1 will detect the rising edge at step 2, and will start charge actuation. At this time, the abnormality judging circuit 5 starts the addition (B) of the applied-voltage signal with which the applied-voltage signal detector 4 outputs the addition (A) of the actual piezo actuator applied voltage which the applied-voltage detector 3 outputs at step 3 at step 4.

[0017] Charge turns ON charge SW at step 5, and after it checks that the charging current has reached the predetermined value (for example, 20A) at step 6, it repeats actuation of turning OFF charge SW at step 8. At this time, the limit (for example, 20 microseconds) of a fixed period (TCON) is prepared, and also when the charging current does not reach a predetermined value (for example, 20A) at step 6, ON time amount of one charge SW turns off Charge SW, after carrying out fixed period (TCON) standby at step 7. Charge will be completed, if it carried out by having repeated this charge actuation and the charge electrical potential difference has reached the predetermined value (for example, 100V) at step 9. Step 3 or subsequent ones is repeated after carrying out fixed period (TCOff, for example, 10 microseconds) standby at step 10 until it reaches a predetermined charge electrical-potential-difference value (for example, 100V), if a predetermined value is not reached. After charge is completed, it returns to step 1.

[0018] With the gestalt of this operation, timing of malfunction detection is made into a certain discharge [of a piezo actuator], and fixed period back as an example. After charge of a piezo actuator is completed, since an applied-voltage signal is in high level (H), when an applied-voltage signal detects a falling edge at step 11, discharge actuation is started at step 1. At this time, the count of an addition result judging timer is started at step 12 by making time amount to the judgment of an addition result (A and B) into N second (for example, 100 microseconds). Like the time of charge, discharge turns ON discharge SW at step 23, and after the discharge current reaches a predetermined value (for example, 20A) at step 14, it is made by repeating actuation of turning OFF discharge SW at step 16. Discharge SW is turned off after carrying out fixed period (TCON) standby at step 15, even if it has prepared the limit (for example, 20 microseconds) of a fixed period (TdoN) and ON time amount of Discharge SW does not reach the discharge current predetermined at step 14 at this time.

[0019] This discharge actuation is repeated until the applied voltage of the piezo actuator 2 starts again. The approach of repeating discharge may be taken until it carries out the monitor of the applied voltage of the piezo actuator 2 and falls to 0V or a predetermined electrical-potential-difference value. In OFF of Discharge SW, if an addition result judging timer is below N second at step 17, return and the following actuation will be repeated to step 1. At step 17, if an addition result judging timer is larger than N second, steps 18 and 19 will compare an addition result (A and B), if the difference is more than a predetermined allowed value, it will detect as abnormalities of the piezo actuator 2, an impression inhibiting signal will be outputted to the drive circuit 1, and charge-and-discharge actuation will be suspended. If the difference of an addition result (A and B) is under a predetermined allowed value at step 19, it will judge with it being normal and will return to step 1.

[0020] As mentioned above, since according to the malfunction detection equipment of this invention actual applied voltage is detected and it compares with an applied-voltage signal, the abnormalities at the time of charge and discharge are certainly detectable. Therefore, safety can be raised more by suspending charge-and-discharge actuation promptly at the time of abnormalities. In addition, although

the abnormality judging period was established after a fixed period from discharge actuation initiation of a piezo actuator with the gestalt of the above-mentioned implementation, if it is the period when the applied-voltage signal is not inputted, there will not necessarily be no need of restricting to this.
[0021] In addition, although the applied-voltage signal outputted to the drive circuit 1 of a piezo actuator from a control unit 10 was explained as a square wave signal with the gestalt of above-mentioned operation in order to carry out charge initiation and discharge starting of the piezo actuator 2, it does not restrict to this. For example, instead of making a square wave signal into an applied-voltage signal, to the timing which performs charge initiation of the piezo actuator 2, an edge signal (1st edge signal) is outputted to the drive circuit 1, it constitutes from timing which performs subsequent discharge starting so that an edge signal (2nd edge signal) may be outputted to the drive circuit 1, and it is good also considering these two edge signals as an applied-voltage signal. And by carrying out the multiplication of time amount until the 2nd edge signal is outputted from the 1st edge signal output, and the predetermined electrical potential difference, the addition value of an applied-voltage signal is calculated, this is compared with the addition value of actual applied voltage, and the same effectiveness is acquired that what is necessary is just to constitute so that the abnormality judging of the piezo actuator 2 may be carried out.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the whole malfunction detection equipment configuration of the piezo actuator of this invention.
[Drawing 2] It is a timing diagram for explaining the fundamental concept of the malfunction detection equipment of the piezo actuator of this invention.
[Drawing 3] It is a flow chart for explaining actuation of the malfunction detection equipment of the piezo actuator of this invention.
[Description of Notations]
1 Drive Circuit (Driving Means)
2 Piezo Actuator
3 Applied-Voltage Detector (Applied-Voltage Detection Means)
4 Applied-Voltage Signal Detector (Applied-Voltage Signal Detection Means)
5 Malfunction Detection Circuit (Malfunction Detection Means)
10 Control Unit (Applied-Voltage Signal Output Means)

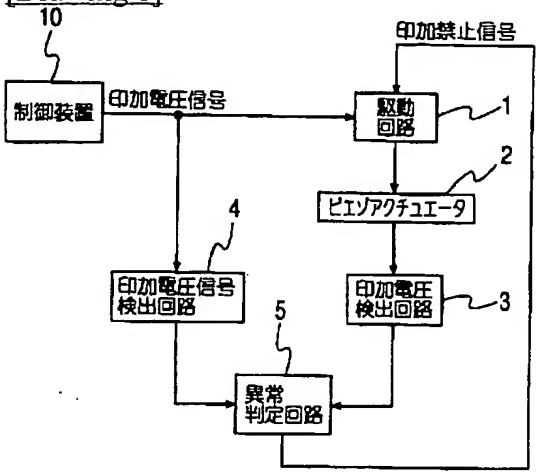
[Translation done.]

* NOTICES *

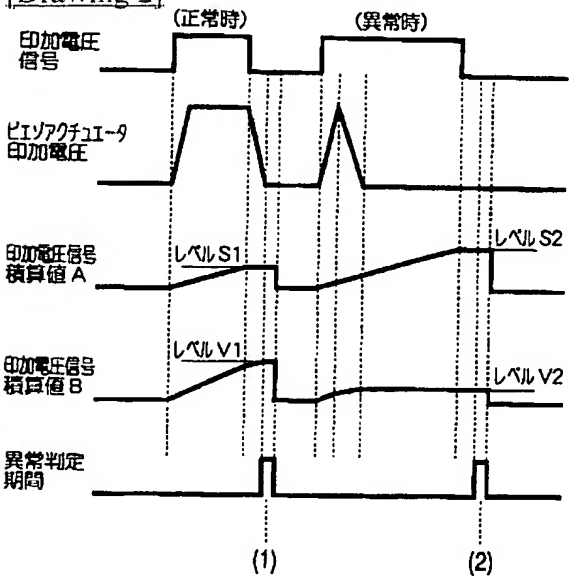
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

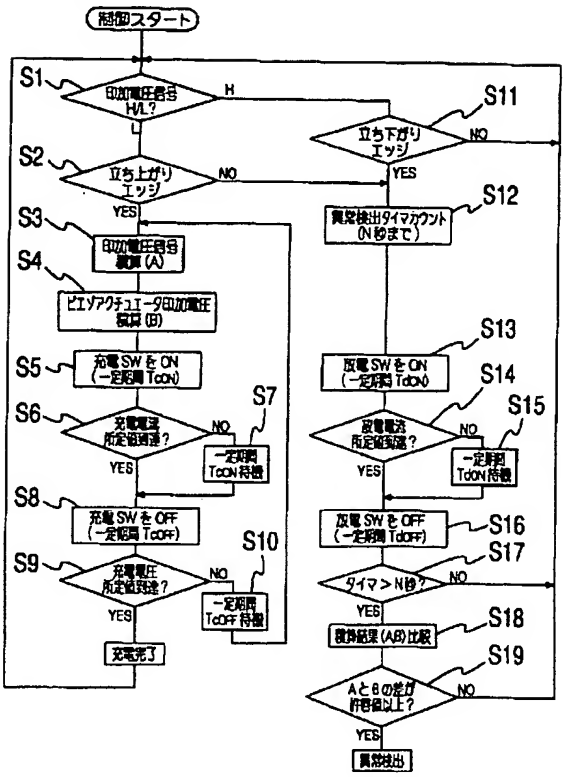
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]